INL/MIS-22-67959-Revision-0

An Initial Assessment of the Creep-Rupture Strengths for Weldments with Alloy 800H Base Metal and Alloy 617 Filler Metal

July 2022

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Idaho National Laboratory

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Background

The expected minimum stress-to-rupture of the weld is a function of the stress rupture factor (R) and the expected minimum stress-to-rupture (S_r) of the base metal.

Where,

$$R = \frac{\text{average rupture strength of the filler metal}}{\text{average rupture strength of the base metal}}$$

Motivation

Table HBB-I-14.10C-1
Stress Rupture Factors for Alloy 800H Welded With SFA-5.11 ENiCrFe-2 (INCO A)

U.S. Customary Units

Temp., °F	10 hr	30 hr	100 hr	300 hr	1,000 hr	3,000 hr	10,000 hr	30,000 hr	100,000 hr	300,000 hr
850–900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
950	1.00	1.00	1.00	1.00	0.98	0.95	0.92	0.90	0.86	0.83
1,000	1.00	1.00	1.00	1.00	0.98	0.94	0.90	0.86	0.82	0.78
1,050	1.00	1.00	1.00	1.00	0.98	0.94	0.89	0.85	0.81	0.76
1,100	1.00	1.00	1.00	1.00	0.98	0.94	0.89	0.84	0.79	0.75
1,150	1.00	1.00	1.00	1.00	0.98	0.93	0.88	0.83	0.77	0.72
1,200	1.00	1.00	1.00	1.00	0.98	0.93	0.87	0.81	0.75	0.70
1,250	1.00	1.00	1.00	1.00	0.98	0.92	0.85	0.80	0.73	0.68
1,300	1.00	1.00	1.00	1.00	0.97	0.91	0.84	0.77	0.71	0.65
1,350	1.00	1.00	1.00	1.00	0.96	0.89	0.82	0.75	0.68	0.62
1,400	1.00	1.00	1.00	1.00	0.95	0.87	0.80	0.73	0.65	0.59

SI Units

Temp., °C	10 h	30 h	100 h	300 h	1 000 h	3 000 h	10 000 h	30 000 h	100 000 h	300 000 h
450–475	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	0.99	0.97	0.95	0.94	0.91	0.89
525	1.00	1.00	1.00	1.00	0.98	0.94	0.91	0.88	0.84	0.80
550	1.00	1.00	1.00	1.00	0.98	0.94	0.90	0.86	0.82	0.77
575	1.00	1.00	1.00	1.00	0.98	0.94	0.89	0.85	0.80	0.76
600	1.00	1.00	1.00	1.00	0.98	0.94	0.89	0.84	0.79	0.74
625	1.00	1.00	1.00	1.00	0.98	0.93	0.88	0.83	0.77	0.72
650	1.00	1.00	1.00	1.00	0.98	0.93	0.87	0.81	0.75	0.70
675	1.00	1.00	1.00	1.00	0.98	0.92	0.85	0.80	0.73	0.68
700	1.00	1.00	1.00	1.00	0.97	0.91	0.84	0.77	0.71	0.65
725	1.00	1.00	1.00	1.00	0.96	0.90	0.83	0.76	0.69	0.63
750	1.00	1.00	1.00	1.00	0.95	0.88	0.81	0.74	0.66	0.60

Table HBB-I-14.10C-2
Stress Rupture Factors for Alloy 800H Welded With SFA-5.14 ERNiCr-3 (INCO 82)

U.S. Customary Units

Temp., °F	10 hr	30 hr	100 hr	300 hr	1,000 hr	3,000 hr	10,000 hr	30,000 hr	100,000 hr	300,000 hr
850–900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
950	0.89	0.90	0.90	0.90	0.89	0.89	0.88	0.87	0.86	0.86
1,000	0.85	0.86	0.86	0.86	0.85	0.85	0.84	0.84	0.82	0.81
1,050	0.88	0.88	0.88	0.88	0.87	0.86	0.85	0.84	0.83	0.81
1,100	0.91	0.91	0.91	0.90	0.89	0.88	0.87	0.85	0.83	0.81
1,150	0.94	0.93	0.93	0.92	0.90	0.89	0.87	0.85	0.83	0.81
1,200	0.96	0.96	0.95	0.93	0.92	0.90	0.88	0.86	0.83	0.81
1,250	0.99	0.98	0.96	0.95	0.93	0.91	0.88	0.85	0.82	0.80
1,300	1.00	1.00	0.98	0.96	0.93	0.91	0.88	0.85	0.82	0.78
1,350	1.00	1.00	0.99	0.96	0.94	0.91	0.87	0.84	0.77	0.68
1,400	1.00	1.00	1.00	0.97	0.94	0.89	0.79	0.71	0.62	0.54

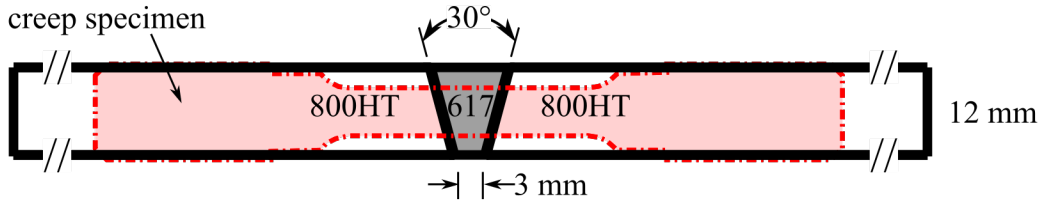
SI Units

Temp., °C	10 h	30 h	100 h	300 h	1 000 h	3 000 h	10 ,000 h	30 000 h	100 000 h	300 000 h
450–475	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
500	0.93	0.94	0.94	0.94	0.93	0.93	0.92	0.92	0.91	0.91
525	0.87	0.88	0.88	0.88	0.87	0.87	0.86	0.85	0.84	0.83
550	0.86	0.87	0.87	0.87	0.86	0.85	0.84	0.84	0.82	0.81
575	0.89	0.89	0.89	0.89	0.88	0.88	0.86	0.84	0.83	0.81
600	0.92	0.92	0.92	0.91	0.89	0.88	0.87	0.85	0.83	0.81
625	0.94	0.93	0.93	0.92	0.90	0.89	0.87	0.85	0.83	0.81
650	0.96	0.96	0.95	0.93	0.92	0.90	0.88	0.86	0.83	0.81
675	0.99	0.98	0.96	0.95	0.93	0.91	0.88	0.85	0.82	0.80
700	1.00	1.00	0.98	0.96	0.93	0.91	0.88	0.85	0.82	0.78
725	1.00	1.00	0.99	0.96	0.94	0.91	0.87	0.84	0.78	0.71
750	1.00	1.00	1.00	0.97	0.94	0.90	0.82	0.76	0.67	0.59

Purpose

An alterative filler metal is desired to improve the creep-rupture strengths of Alloy 800H weldments for the qualified temperatures and services lives. This work investigates an Alloy 800H weldment with Alloy 617 filler metal fabricated by semiautomated gas tungsten arc welding (GTAW).

Experimental Methodology



Chemistry of the Alloy 800HT base metal and Alloy 800H chemistry requirements specified in Division 5 in weight percent

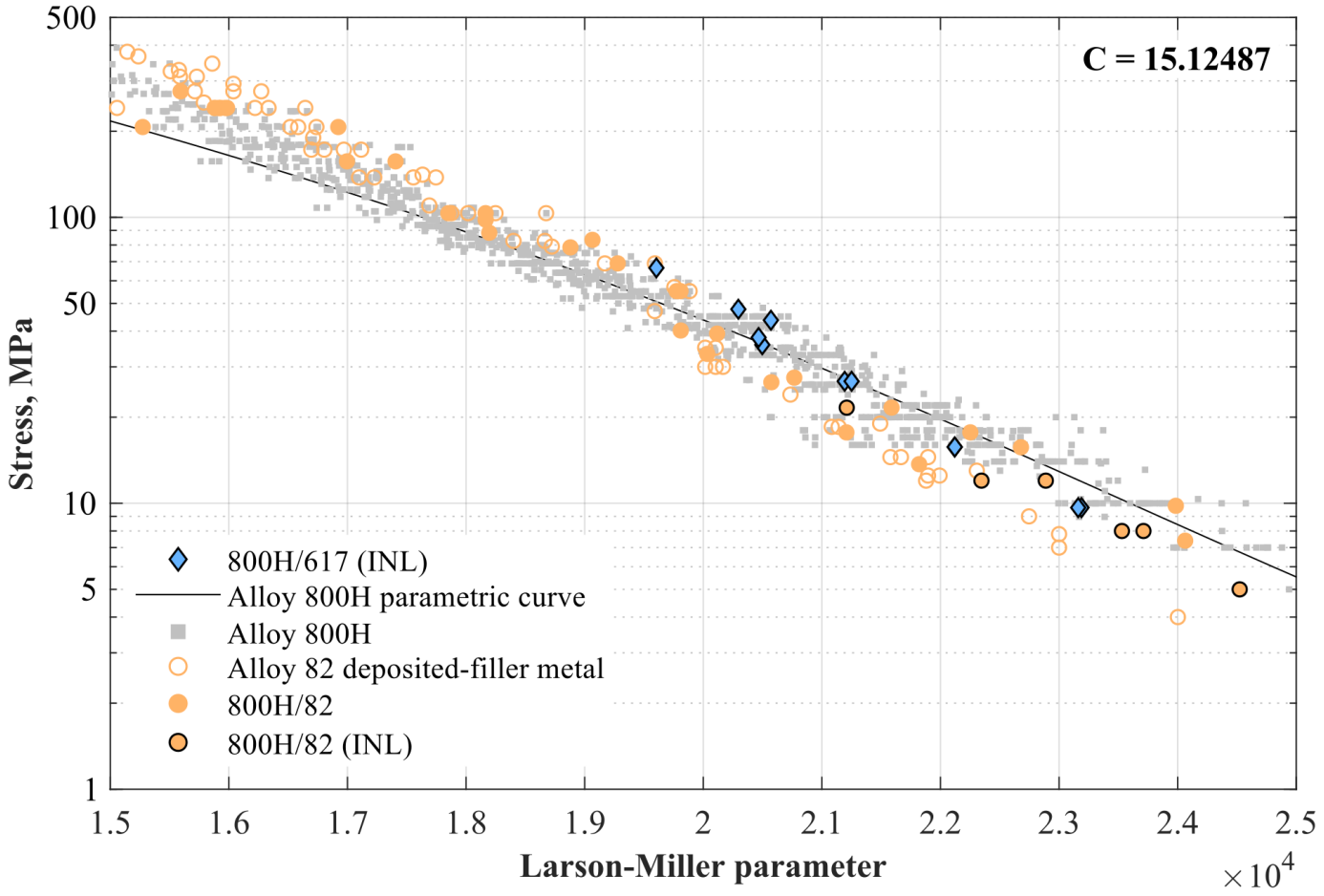
		Ni	Cr	Fe	Mn	C	Cu	Si	S	Al	Ti	Mo	Co
800HT base metal		30.45	19.30	47.05	1.31	0.063	0.21	0.37	0.001	0.43	0.45	0.21	0.11
Division 5 requirements	minimum	30.0	19.0	39.5	-	0.05	-	-	-	0.15*	0.15*	-	-
	maximum	35.0	23.0	-	1.5	0.10	0.75	1.0	0.015	0.60*	0.60*	-	-

* Al + Ti ≥ 0.50%

Chemistry of the Alloy 617 filler metal in weight percent

Ni	Cr	Co	Mo	Fe	Mn	Al	C	Cu	Si	S	Ti
53.91	22.41	11.49	8.98	1.37	0.11	1.10	0.89	0.04	0.04	0.001	0.34

Results and Discussion



Swindeman, Robert, Swindeman, Michael, Roberts, Blaine, Thurgood, Brian, and Marriott, Douglas. "Verification of Allowable Stresses in ASME Section III Subsection NH for Alloy 800H." Technical Report No. STP-NU-020. ASME Standards Technology, LLC., New York, NY (2008).

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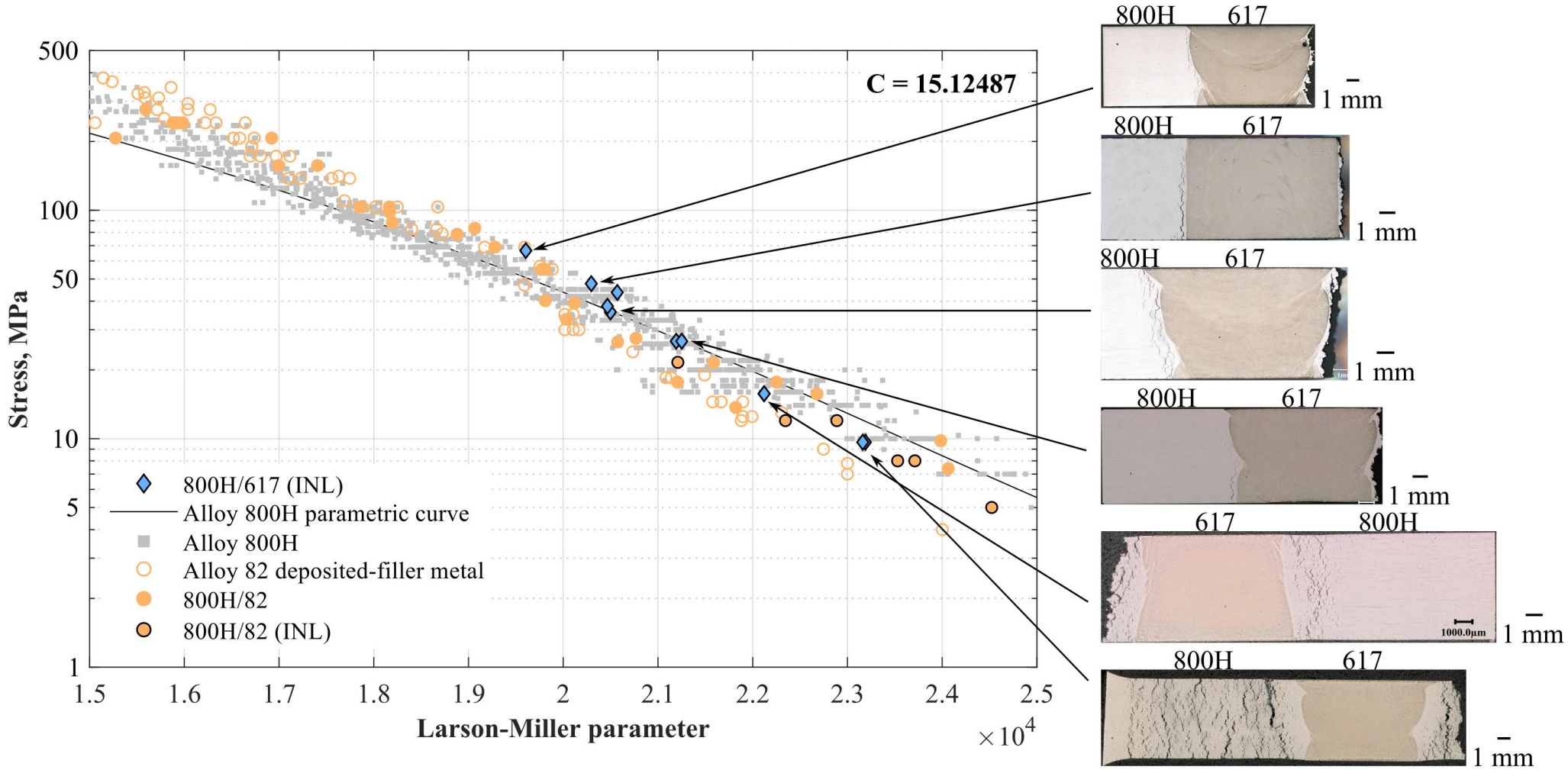

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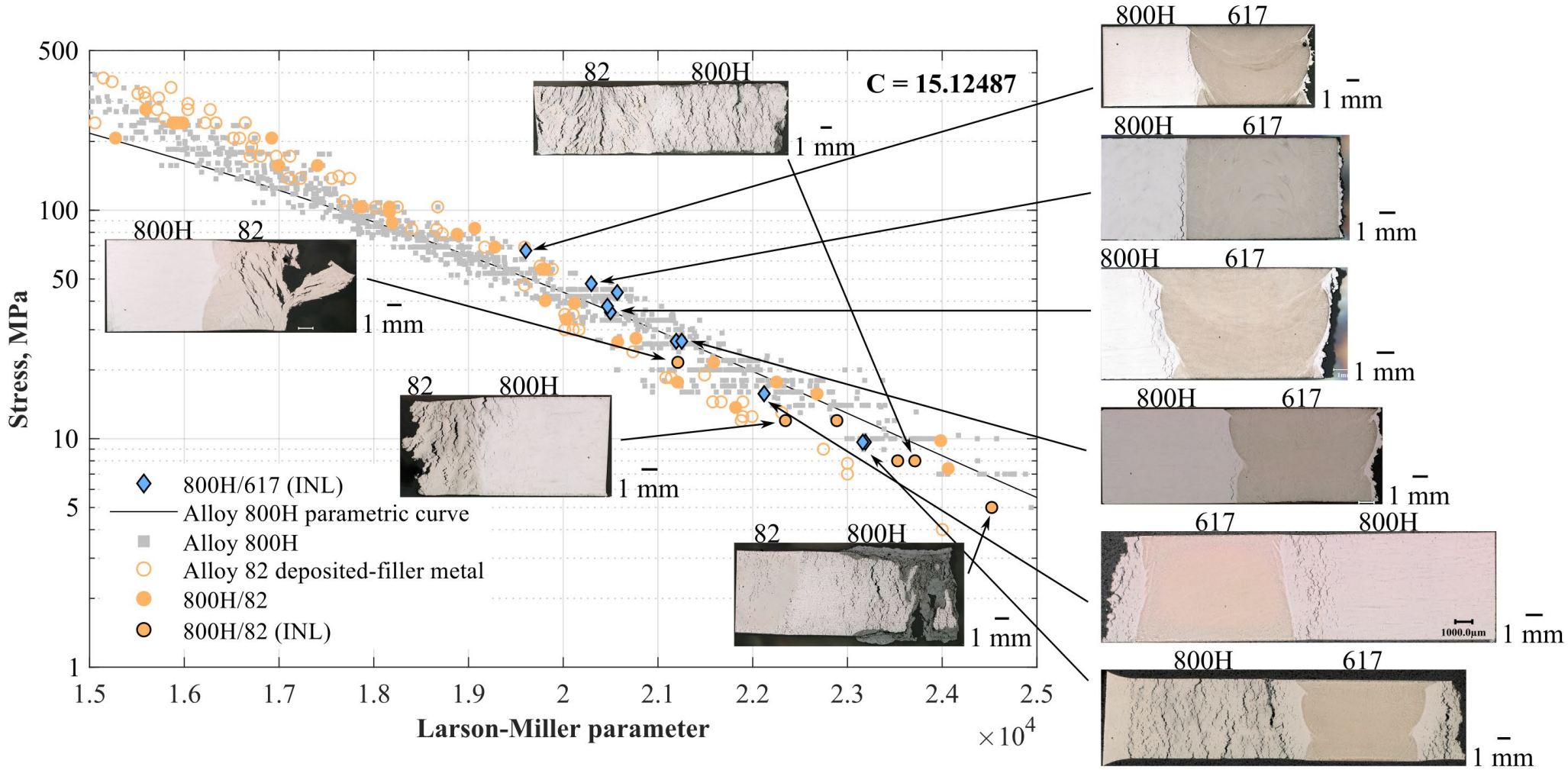

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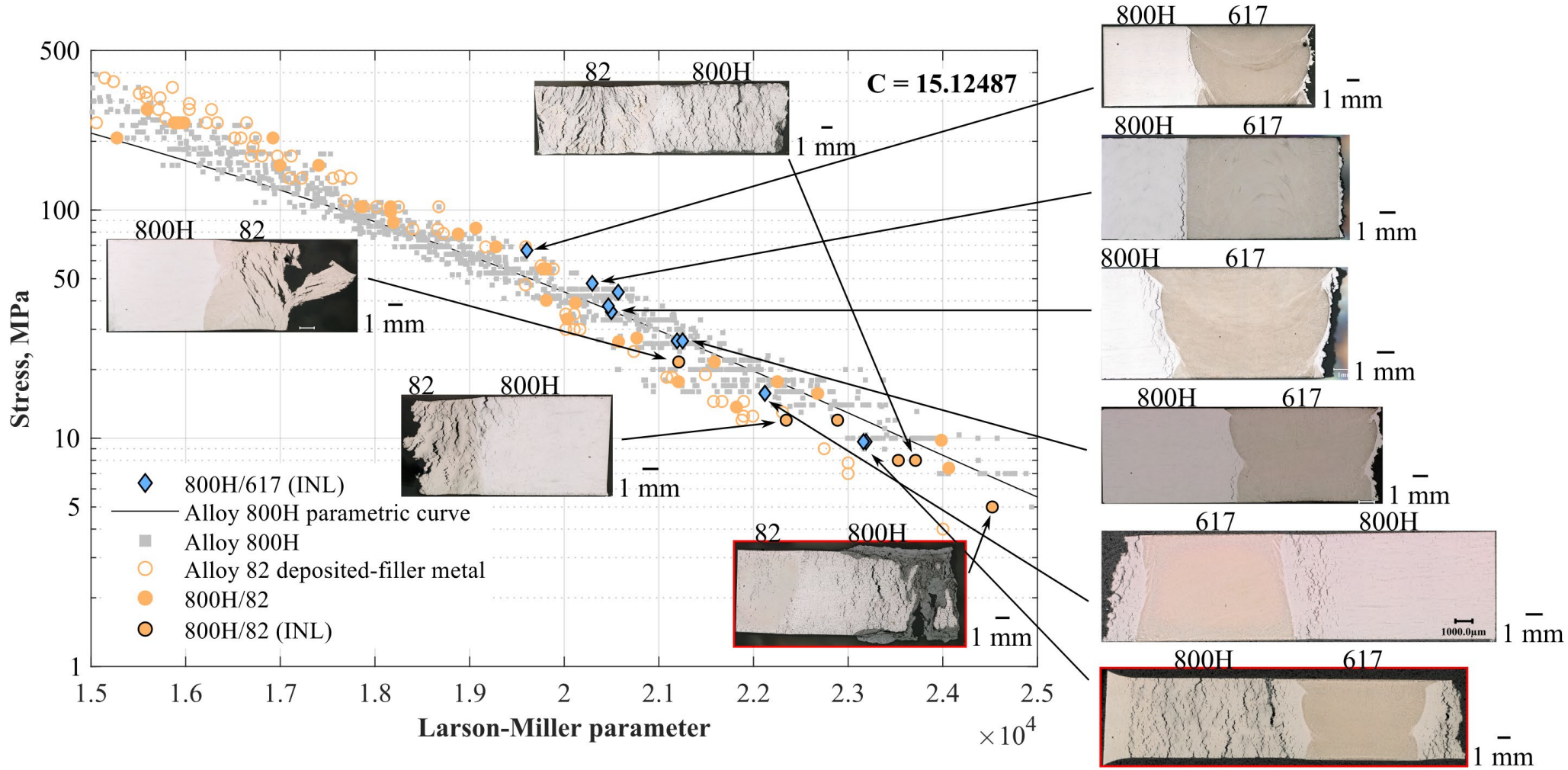

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Conclusion

- Preliminary creep-rupture data of the Alloy 800H weldment with Alloy 617 filler metal do not show significant improvement compared to the filler metals currently permitted in Division 5 for Alloy 800H weldments.
- Therefore, Alloy 617 filler metal is unlikely to offer significantly improved stress rupture factor values for Alloy 800H weldments.
- An alternative filler metal for Alloy 800H weldments with improved creep-rupture strengths compared to the Division 5 permissible filler metals continues to be pursued. UTP A 2133 Mn is currently being investigated.

Acknowledgements

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